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(21) International Application Number: PCT/EP98/03737 (22) International Filing Date: 18 June 1998 (18.06.98) (30) Priority Data: 97/5460 20 June 1997 (20.06.97) ZA (71) Applicant (for all designated States except US): EVERMINE LIMITED [GB/CH]; Mayo Associates, 1st floor, 7, Pictet de Rochmont, CH-Geneva (CH). (72) Inventors; and (75) Inventors/Applicants (for US only): JOUBERT, Kenneth, Alfred [ZA/ZA]; 50 Paul Kruger Road, South Crest, Johannesburg, Gauteng (ZA). VAN VUUREN, Hendrik, Johannes [ZA/ZA]; 1 Bramley Drive, Parkhill Gardens, Lambton, Germiston, Gauteng (ZA). (74) Agent: GALGUT, John; Gouldens, 22 Tudor Street, London EC4Y OJJ (GB).	(81) Designated States: AL, AM, AT, AT (Utility model), AU (Petty patent), AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published Without international search report and to be republished upon receipt of that report.
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(54) Title: SURFACE COVERING MATERIAL

(57) Abstract

A surface covering material is described which can be applied on to for example rock and coal surfaces (for convenience both rock and coal will further in this specification be referred to as "rock") in tunnels, stopes and pillars as well as around base plates of rock bolts to inhibit the breaking away of the rock covered thereby. The material comprises a mixture of a cementitious constituent, comprising a highly water absorbent cement blend, with a second constituent which incorporates a water based polymer emulsion. The highly water absorbent cement blend can absorb at least its own mass of water and in some cases five times its own mass of water. The covering material will dry quickly in mines where there is high humidity and little air movement.

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Surface Covering Material

This invention relates to surface covering materials.

In our South African Patent Specification No 94/0532 there is described such surface covering materials. Although these materials have many excellent properties, they have a weakness when used underground. The problem in mines is the high humidity in the atmosphere and the fact that there is often very little air movement. In this situation, it has been found that the aforesaid materials take a fair amount of time to dry and cure which may be unacceptable in certain circumstances.

According to one aspect of the present invention there is provided a surface covering material comprising a mixture of a cementitious constituent, comprising a highly water absorbent cement blend, with a second constituent which incorporates a water based polymer emulsion. This material can be applied on to for example rock and coal surfaces (for convenience both rock and coal will further in this specification be referred to as "rock") in tunnels, stopes and pillars as well as around base plates of rock bolts to inhibit the breaking away of the rock covered thereby.

The term "highly water absorbent" should be construed in accordance with the following:- Ordinary Portland cement ("OPC") will absorb water in the

following proportions, viz 100 gm OPC to about 38 gm water. A "highly water absorbent cement blend" will absorb at least its own mass of water. The cementitious constituent preferably will absorb at least three times its mass of water and in a preferred embodiment will absorb five times its mass of water.

Because the cementitious constituent is highly water absorbent, it can better absorb the liquid component of the second constituent. Furthermore for this reason the cementitious constituent can overcome the problem which would otherwise be encountered namely that the polymer coats a large proportion of the granules of the solid constituent thereby preventing the formation of an adequate amount of ettringite.

The second constituent may be a liquid constituent. Alternatively the second constituent may be a dry material.

The surface covering material is preferably applied by being sprayed on to the rock surface. For this purpose the constituents are preferably mixed prior to being sprayed on to the rock surface. The mixture will normally have a limited pot life and therefore will have to be sprayed within a certain period, normally about twenty to thirty minutes after mixing.

Where the second constituent is a dried material, the two constituents are conveniently mixed or blended together and the water added to the mixture in the appropriate amount. Alternatively, the mixture of the dry materials and water may be sprayed on to the surface by a process similar to the "Gunite" process.

The cementitious and second constituents are preferably mixed in the ratio of 1:3. (All ratios and percentages referred to in this specification are on the basis of mass:mass.)

The cementitious constituent preferably comprises high-alumina cement, OPC and anhydrite gypsum (anhydrous calcium sulphate) forming the bulk of the mixture together with soda ash, lithium carbonate and sodium fluoride and conveniently in addition Natrasol®250HR or Cellosize®QP 52000. The items mentioned above as forming the bulk of the mixture may constitute 99% or more of the mixture. We have found that the minor constituents react with the major constituents to provide the highly water absorbent characteristic to the cementitious constituent.

The OPC may comprise between 40% and 52% and preferably about 47% of the cementitious constituent. The high alumina cement may comprise between 18% and 28% and preferably about 23% of the cementitious constituent. The anhydrite gypsum may comprise between 27%

and 31% and preferably about 29% of the cementitious constituent.

The sodium fluoride is preferably a light 95% technical grade sodium fluoride.

5 The soda ash should be finely ground soda ash. The soda ash and the sodium fluoride may each comprise between 0,25% and 0,35% and preferably about 0,3% of the cementitious constituent. The lithium carbonate and Natrasol (or Cellosize) may each comprise between 0,09% and 0,15% and preferably about 0,1% of the cementitious constituent.

10 Preferably the second constituent further comprises a fire retardant. A preferred fire retardant comprises antimony trioxide and chlorinated paraffin, the latter preferably being that sold under the trade name "Cereclor™ 70". This fire retardant preferably constitutes about 10% to 20% of the second constituent. The chlorinated paraffin conveniently constitutes between 8% and 12%, preferably between 10% and 11% and most preferably about 10,7% of the second constituent while the antimony trioxide conveniently constitutes between 3% and 7%, preferably between 5% and 5,5% and most preferably about 5,4% of the second constituent.

25 The emulsion is preferably an acrylic emulsion binder, conveniently a vinyl acetate ethylene copolymer

and preferably that which is commercially available under the trade name "Airflex™ 300". This material forms a binder for the applied surface covering layer giving improved flexibility, elasticity and tensile strength to the cured surface covering layer. In addition it provides improved adhesion to the rock surface. The vinyl acetate ethylene copolymer conveniently constitutes between 60% and 75%, preferably between 65% and 70% and most preferably about 67,6% of the second constituent

A plasticizer is preferably included to improve the flexibility and resilience of the material once it has cured. In particular the plasticizer will assist in providing resilience and flexibility over small radii such as are encountered at rock edges during rockmass deformations under slow and rapid loading conditions. A preferred plasticizer is dibutyl phthalate. The plasticizer may constitute between 5% and 10%, preferably between 7% and 8% and most preferably about 7,8% of the second constituent.

A bactericide for preventing growth of bacteria and enzymes may be provided. This is conveniently in the form of the material commercially obtainable under the trade name "Metatin™ G.T.". Only a small amount of the bactericide need be added and this may be less than 1%, conveniently between 0,1% and 0,2% and preferably about 0,13% of the second constituent.

An anti-foaming agent is also preferably added to prevent foaming and consequent trapping of air in the product and resultant reduction in the strength of the set product. Two preferred anti-foaming agents are
5 BEVALOID® 513 and NEPCO® ADW. Only a small amount of such agent need be provided and this may be less than 0,5% and conveniently between 0,1% and 0,3% of the second constituent. The amount of anti-foaming agent can be adjusted and in particular supplemented on
10 inspection during the mixture of the product.

The covering material is preferably provided with a thickener which preferably forms thixotropic viscosity build and helps to prevent sag. Preferably this is provided in the second constituent. A preferred
15 thickener is ATTAGEL® 50. It is preferably added as a 15% aqueous suspension. This suspension solution may comprise between 2% and 4% and preferably about 2,7% of the second constituent.

The second constituent may further comprise a relatively small amount of water constituting conveniently between 2% and 10%, more conveniently between 4,5% and 6% and preferably about 5,4% of the mass of the second constituent. Alternatively, as mentioned above,
20 the second constituent may be a dry material formed preferably by drying the emulsion as well as any other liquid containing materials and then blending this dried product with any further solid materials.
25

According to another aspect of the invention there is provided the second constituent of the surface covering material set out above. According to a further aspect of the invention there is provided the cementitious constituent of the surface covering material set out above.

According to yet another aspect of the invention there is provided a method of reinforcing a rock surface in a mine comprising applying a layer of the above material to the said surface and permitting it to set.

Examples of the surface covering material will now be described by way of example.

EXAMPLE I

A surface covering material comprises a first cementitious constituent and a second liquid constituent.

A 1000 kg mix of the solid constituent comprises :-

	<u>Description</u>	<u>Mass in kg</u>	<u>%</u>
	High Alumina cement	230,0	23,0
	OPC	470,00	47,0
	Anhydrite Gypsum (anhydrous Calcium sulphate)	292,0	29,2
5	Finely Ground Soda Ash		
	E.P./V.S.P	3,0	0,3
	Sodium Fluoride 95% light tech- nical grade	3,0	0,3
	Lithium carbonate (99% pure)	1,0	0,1
10	Natrasol® 250 H.R.	1,0	0,1
		1000	100,0

We have found that 100 gm of this cementitious mixture will absorb at least 500 gm water. It is therefore highly water absorbent.

The liquid constituent comprises:-

	<u>Description</u>	%
Airflex 300™	Emulsion binder	67,57
dibutyl phthalate	plasticizer	7,81
Antimony trioxide	flame retardant	5,38
Cereclor 70™	flame retardant	10,77
5 15% aqueous sol-		
ution of Attagel™	anti-sag agent	2,69
Acticide	bactericide	0,13
Anti-foam		0,26
Water		5,39
		<hr/> <hr/> 100,00 <hr/> <hr/>

10 The components of the second constituent are mixed together in a high speed mixer until the flame retardants are dispersed, i.e. for between ten to twenty minutes at ambient temperature.

15 The cementitious and liquid constituents are now mixed together at ambient temperature in a hopper of a special sprayer in a ratio of three parts liquid constituent to one part cementitious constituent. The mixture is stirred continually until it is used. The mixture will set within about thirty minutes and therefore should be used within about twenty minutes of mixing. The mixture is sprayed on to the rock surface to provide a layer of not less than 20 mm thick. The

spraying rate of the mixture is between two and three hundred litres per hour.

We have found that the cement constituent absorbs the water in the second constituent so that the surface 5 layer will dry to a dry film even in conditions of 100% humidity so that it, the surface layer, will cure sufficiently to be self-supporting within fifteen minutes and to be able to give initial support for the rock within two to three hours. When fully cured, which 10 will normally take about twenty eight days, the layer will have a uni-axial tensile strength of not less than 1,5 mega-pascals. The layer is also adequately flexible having an elongation of between fifty and sixty per cent. These characteristics enable the layer to 15 form a confinement for the rock to control the disintegration of the rock surface and to improve stability of the rock mass. This is because the flexible layer will assist in dissipating energy release, will assist in controlling the rock deformation and will keep the key 20 blocks in place thereby assisting in reducing rock falls and further will assist in holding the rock coherently even when there is a high rate of energy release. Of course this strength is limited and under extremely high forces the layer will fail. It, the cured layer, 25 will have adequate adhesion to most rock substrates found in the mines.

The spraying machinery and the hopper can be cleaned with water and the waste water can run away and join other water in the mines. It is not necessary to provide toxic liquid for the cleaning of the parts. The constituents for producing the surface covering layer and the mechanical equipment for this purpose are relatively inexpensive.

EXAMPLE II

The constituents are formed as in Example I. A spray nozzle fitted with a mixing device on its inlet is used. The mixing device comprises a static spiral mixer comprising spiral segments arranged so that each consecutive segment rotates the mix passing through tube in a direction opposite to that of the previous segment.

The constituents are fed separately to the nozzle and the mixing device blends the two constituent prior to entering the spray nozzle which now applies the blend to the surface of the rock to be coated.

EXAMPLE III

The cementitious constituent is as described in Example I. A blend of liquid polymers and plasticizers are dried in an air drier to remove the water. This forms a dry powder. The dry powder is then blended with the remaining solids of the second constituent.

The cementitious and second constituents are then blended with one another. The hydrating water is now added to the mixture in the mine at the site where it is required to coat the rock. The product is stirred
5 and then applied as mentioned in Example I.

EXAMPLE IV

The dry mixture of the first and second constituents is prepared as described in Example III. The dry mixture and water are applied under pressure to
10 the rock surface by means of a "Gunite" nozzle. This nozzle is fitted inside with a perforated manifold through which water is introduced under pressure to be mixed with the solid material that is pneumatically conveyed to the nozzle. The mixture is applied to the
15 rock surface.

The rock covering materials applied in accordance with Examples II, III and IV have the same advantages as those as described in Example I.

The invention is not limited to the precise details
20 set forth in the examples. The constituents of the material may vary or be altered. For example hydrophilic fibres or glass fibres of between say 0,5 and 12 mm may be added to the material to increase the tensile strength of the cured layer especially in the post
25 failure stage. Alternative flame retardants, bacteri-

cides and anti-foaming agents may be used. Further additional water may be added to lower the viscosity of the second constituent.

If desired a foaming agent may be added to the
5 second constituent (and the anti-foaming agent removed) so that a foamed layer of the material may be sprayed on to the cured or partially cured layer. This foamed layer may be about thirty five to seventy five and preferably fifty millimetres thick. The foamed layer
10 will provide thermal insulation for the rock walls and will inhibit heat from the rock entering into the working spaces of the mine.

CLAIMS

1. A surface covering material comprising a mixture of a cementitious constituent and a second constituent characterised in that the cementitious constituent comprises a highly water absorbent cement blend and the second constituent incorporates a water based polymer emulsion.
2. A material as claimed in claim 1 characterised in that the cementitious constituent will absorb its own mass of water.
3. A material as claimed in claim 2 characterised in that the cementitious constituent will absorb about five times its own mass of water.
4. A material as claimed in claim 1, 2 or 3 characterised in that the cementitious mixture comprises high-alumina cement, ordinary portland cement and anhydrite gypsum (anhydrous calcium sulphate) forming the bulk of the mixture together with soda ash, lithium carbonate and sodium fluoride.
5. A material as claimed in claim 4 characterised in that it further comprises Natrascl®250HR or Cellosize®QP 52000.

6. A material as claimed in claim 4 or 5 characterised in that the high alumina cement, ordinary portland cement and anhydrite gypsum constitute 99% or more of the cementitious constituent.

7. A material as claimed in claim 4, 5 or 6 characterised in that the ordinary portland cement comprises between 40% and 52% and preferably about 47% of the cementitious constituent.

8. A material as claimed in claim 4, 5, 6 or 7 characterised in that the high alumina cement comprises between 18% and 28% and preferably about 23% of the cementitious constituent.

9. A material as claimed in any one of claims 4 to 8 characterised in that the anhydrite gypsum comprises between 27% and 31% and preferably about 29% of the cementitious constituent.

10. A material as claimed in any one of claims 4 to 9 characterised in that the soda ash comprises between 0,25% and 0,35% and preferably about 0,3% of the cementitious constituent.

11. A material as claimed in any one of claims 4 to 10 characterised in that the sodium fluoride comprises between 0,25% and 0,35% and preferably about 0,3% of the cementitious constituent.

12. A material as claimed in any one of claims 4 to 11 characterised in that the lithium bicarbonate comprises between 0,09% and 0,15% and preferably about 0,1% of the cementitious constituent.

13. A material as claimed in any one of claims 4 to 12 characterised in that the Natrasol comprises between 0,09% and 0,15% and preferably about 0,1% of the cementitious constituent.

14. A material as claimed in any one of the preceding claims characterised in that the second constituent further comprises a fire retardant.

15. A material as claimed in claim 14 characterised in that the fire retardant comprises antimony trioxide and chlorinated paraffin.

16. A material as claimed in any one of the preceding claims characterised in that the emulsion is an acrylic emulsion binder.

17. A material as claimed in claim 16 characterised in that the emulsion is a vinyl acetate ethylene copolymer.

18. A material as claimed in claim 17 characterised in that the vinyl acetate ethylene copolymer constitutes between 60% and 75%, preferably between 65% and 70% and most preferably about 67,5% of the second constituent.

19. A material as claimed in claim 18 characterised in that a plasticizer is included.

20. A material as claimed in claim 19 characterised in that the plasticizer is dibutyl phthalate.

21. A material as claimed in claim 19 or 20 characterised in that the plasticizer constitutes between 5% and 10%, preferably between 7% and 8% and most preferably about 7,8% of the second constituent.

22. A material as claimed in any one of the preceding claims characterised in that a bactericide for preventing growth of bacteria and enzymes is provided.

23. A material as claimed in any one of the preceding claims characterised in that an anti-foaming agent is added to the second constituent.

24. A material as claimed in claim 23 characterised in that the foaming agent comprises less than 0,5% and conveniently between 0,1% and 0,3% of the second constituent.

25. A material as claimed in any one of the preceding claims characterised in that the covering material is provided with a thickener which preferably forms thixotropic viscosity build and helps to prevent sag.

26. A material as claimed in claim 25 characterised in that the thickener is provided in the second constituent.

27. A material as claimed in claim 26 characterised in that the thickener is added as a 15% aqueous solution which preferably comprises between 2% and 4% and preferably about 2,7% of the second constituent.

28. A material as claimed in any one of the preceding claims characterised in that the first and second constituents are mixed in the proportions of one to three.

29. For use in a covering material as claimed in claim 1, a cementitious constituent characterised in that it comprises high-alumina cement, ordinary portland cement and anhydrite gypsum (anhydrous calcium sulphate) together with soda ash, lithium carbonate and sodium fluoride.

30. A cementitious constituent as claimed in claim 29 characterised in that it further comprises Natrasol®250HR or Cellosize®QP 52000.

31. For use in a covering material as claimed in claim 1, a second constituent characterised in that it comprises a liquid constituent.

32. For use in a covering material as claimed in claim 1, a second constituent characterised in that it comprises a dry solid constituent.

33. A method of reinforcing a rock surface in a mine characterised in that a layer of the surface covering material as claimed in any one of claims 1 to 28 is applied to the said surface and permitted to cure.

34. A method as claimed in claim 33 characterised in that the surface covering material is applied to the said surface by being sprayed on to the surface.

35. A method as claimed in claim 34 when dependant upon claim 32 characterised in that the dry constituents and water are sprayed on to the said surface by a "Gunite" process.



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(71) Applicant (<i>for all designated States except US</i>): EVERMINE LIMITED [GB/CH]; Mayo Associates, 1st floor, 7, Pictet de Rochmont, CH-Geneva (CH).			
(72) Inventors; and			
(75) Inventors/Applicants (<i>for US only</i>): JOUBERT, Kenneth, Alfred [ZA/ZA]; 50 Paul Kruger Road, South Crest, Johannesburg, Gauteng (ZA). VAN VUUREN, Hendrik, Johannes [ZA/ZA]; 1 Bramley Drive, Parkhill Gardens, Lambton, Germiston, Gauteng (ZA).		Published <i>With international search report.</i>	
(74) Agent: GALGUT, John; Gouldens, 22 Tudor Street, London EC4Y OJJ (GB).		(88) Date of publication of the international search report: 25 March 1999 (25.03.99)	

(54) Title: SURFACE COVERING MATERIAL

(57) Abstract

A surface covering material is described which can be applied on to for example rock and coal surfaces in tunnels, stopes and pillars as well as around base plates of rock bolts to inhibit the breaking away of the rock covered thereby. The material comprises a mixture of a cementitious constituent, comprising a highly water absorbent cement blend, with a second constituent which incorporates a water based polymer emulsion. The highly water absorbent cement blend can absorb at least its own mass of water and in some cases five times its own mass of water. The covering material will dry quickly in mines where there is high humidity and little air movement.

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C09D1/08 C04B26/06 C04B26/04 C04B28/04

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 825 457 A (ST. HELENS CABLE & RUBBER COMPANY LIMITED) see page 1, line 10 - line 64 see page 2, line 14 - line 23 ---	1-3
X	DE 27 02 984 A (FERENCAK FRIEDRICH M) 27 July 1978 see page 6; example 6 ---	1-3
Y	US 5 454 866 A (GILBERT GREGORY M ET AL) 3 October 1995 see column 1, line 59 - column 2, line 47 see column 10, line 45 - line 61 --- -/-	1,29

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